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FEDERAL COMMUNICATIONS COMMISSION  
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P R Docket 92-235

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## TECHNICAL COMMENTS OF

CITY OF HOUSTON TEXAS POLICE DEPARTMENT

~~Respectfully submitted,~~

**May 15, 1993**

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**CITY OF HOUSTON TEXAS POLICE DEPARTMENT**

**REFARMING ISSUES**

**Docket 92-235**

**Technical Summary by:**

**Houston Police Communications Management Division**

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1. **The Federal Communications Commission is to be commended on their efforts to promote the efficient use of the frequency bands below 512 MHz allocated to the Private Land Mobile Radio services. The reliability of Private Land Mobile Radio (PLMR) communications is reduced due to many factors. Solutions provided in PR Docket 92-235 are innovative and set goals for equipment users and manufacturers that emphasize spectrum efficient standards. The development of a new set of rules with flexible technical and operational characteristics for the PLMR is very different from current standards and will become a welcome change in policy. Your stated goal, " ..to develop a regulatory scheme that increases channel capacity for PLMR users .. (&) ..sensitive to the need for a reasonable transition period for users to convert their radio systems to newer, more spectrum efficient technologies.. " takes a critical step in providing for the long term reliability of PLMR spectrum. The comments in this document focus on issues of greatest concern to the Houston Police Department. Major issues are:**
  - a. **Implementation cost**
  - b. **Coverage area**
  - c. **Interference**
  - d. **Technical and operational rules**

2. Additional radio spectrum is needed in many parts of the country. The cost to make the transition to the new technical standards is more than a screwdriver adjustment. A large portion of the existing radios will need more than a conversion kit. Refarming could result in more efficient spectrum usage but refarming will also come at a very high price. A natural transition, when the price of narrowband equipment comes down and availability increases, will make the requirement to change equipment feasible and cost effective.
3. (l) Introduction, Paragraph 2 of the Notice Of Proposed Rule Making states "We are convinced that, without significant regulatory changes in the bands below 512 MHz, the quality of PLMR communications will likely deteriorate to the point of endangering public safety and the national economy." Public safety requires a very high level of quality in the ability to communicate by radio emission. Police and Fire communications rank at the top priority for reliability second only to national defense communication issues. Current communication system features that are utilized with presently operating users should be preserved allowing for efficient communication procedures.
4. Economic issues motivate selection processes for various goals. Notice of Proposed Rule Making, I. Introduction, paragraph 2, endangering of the national economy by poor communication emission efficiencies suggests a larger than previously modeled dependence upon the radio spectrum by business in general. Economic dependence and negative impact is observable among the public safety radio users.
5. Docket 92-235 gives radio equipment manufacturers a guaranteed "New Market" at the final expense of the general public who must fund changes, either directly or indirectly, in the various communication systems that they interface with. In past history, changes and improvements in technology have provided equipment manufacturers with new products having measurable additional functionality over those being replaced. Product availability has

driven the marketplace and stimulated changes in regulations when necessary. Narrow band product availability is not the current "watch word" for manufacturers. Availability dates, product identification, and pricing remain unspecified. Industry support for the spectrum efficiency proposal appears lacking.

6. This docket could be renamed "A Vendor Assistance Act" . On first inspection, equipment manufactures appear to receive the greatest monetary benefit. When considering economic dependance factors, the service provider will profit more with acquisition of finite resources (radio spectrum) that allow the construction of new multi-user / service communication systems. § 88.309 Interservice use of frequencies in the 150-174, 421-430, and 450-470 MHz bands provide commercial (vendor) use of a finite resource not previously made available. This section could provide SMR entry into new spectrum previously held and occupied by other services. The proximity of this spectrum to existing public safety systems and the co-location of common sites bring great concern and uncertainty in the performance and reliability of emergency communication systems. Any increase in interference can not be tolerated.
7. Adjacent channel coordination is one of public safety's major problem areas. Interspersing of SMR channels into public safety blocks is not a workable solution. Commercial users operate in wide and often undefined geographic areas. Public safety users have defined geographic jurisdictions for their required operation. SMR mobiles on adjacent channels will operate within the range of public safety users. Any Increase in interference can not be tolerated.
8. Wider bandwidth data system development is possible by combining adjacent channels. Interspersing of SMR channels into public safety blocks will limit future data system development of this type. Public safety spectrum should be contiguous thus allowing spectrum efficient management from a single frequency coordinator / manager. §88.433 Spectrum efficiency standards, will

allow the development of efficient data systems that require contiguous spectrum. Data systems have higher average message throughput than voice systems thus providing superior channel efficiency.

9. Interleaving of non-public safety services with those of public safety in certain portions of radio spectrum could produce undesirable communication quality and reliability for the following reasons:

- a. Adjacent channel interference
- b. Receiver desensitization
- c. Interleaving of non-public safety services with those of public safety destroys the integrity of block allocations.
- d. Service area operational profiles differ.

Block allocations should be as contiguous as possible providing control over adjacent channel interference.

10. The exemption placed on 2 watt mobile stations in §88.417, Modulation requirements, should be eliminated. A 2 watt mobile can produce system wide adjacent channel interference for multiple receiver configuration channels that are common in large public safety operations. Interference must be minimized from all sources.
11. Communication equipment has changed with application of newer semiconductor technologies providing for an increased equipment life cycle. The Houston Police Department Communication Management Division utilizes current communication technology ( VHF & UHF) in its radio system composition. Equipment is replaced based upon life cycle, wear, and operational reliability. Current and planned (near future purchase) radio equipment provide no migration path allowing narrow or reduced bandwidth operation.

12. Field modification of current communications equipment appears prohibitive after consulting with equipment manufacturers. Conversion of this equipment to a narrow bandwidth compatibility involves the following problem areas:
- a. incompatibility with proposed channel assignments
    - i. offsets
  - b. modulation standards
    - i. department paging system not compatible with reduced deviation levels
    - ii. Mobile Data Terminal System not compatible with reduced deviation levels and channel bandwidth

reduce the occupied bandwidth to 10 kHz by January 1, 1996 allowing for the creation of three channels from every one currently used. Footnote 3 stated that adjacent channel protection would not be provided and that to avoid such problems, licensees should reduce the receiver bandwidth of existing equipment to minimize adjacent channel interference from newly created channels. Any increase in interference can not be tolerated.

14. Modifications resulting in the reduction of receiver bandwidth are not in the best interest of the Houston Police Department given the quantity of equipment owned and overall cost to the community. The following list summarizes police department equipment requiring bandwidth modification - 6,928 pieces of equipment having a value of \$11,986,600.00

a. mobile radio

- i. total quantity in inventory is 3499
- ii. total value @\$1,500.00 is \$5,248,500.00
- iii. possible estimated cost of modification
  - (1) materials @\$500.00/unit is \$1,749,500.00
  - (2) time @2 Hr is 999.71 man/days (7 Hr/ shift/ day)
  - (3) labor cost @\$60.00 Hr is \$419,880.00

b. portable radio

- i. total quantity in inventory is 3218
- ii. total value @\$1,700.00 is \$5,470,600.00
- iii. possible estimated cost of modification
  - (1) materials @\$800.00/unit is \$2,574,400.00
  - (2) time @2 Hr is 919.43 man/ days (7Hr/ shift/ day)
  - (3) labor cost @ \$60.00 Hr is \$386,160.00

c. fixed station receiver

- i. total quantity in inventory is 165
- ii. total value @ \$3,500.00 is \$577,500.00
- iii. possible estimated cost of modification
  - (1) materials @ \$500.00/unit is \$82,500.00

- (2) time @2 /day (field work) is 82.5 man/ days
    - (3) labor cost @ \$480.00/ day is \$39,600.00
  - d. fixed station transmitter
    - i. total quantity in inventory is 46
    - ii. total value @\$15,000.00 is \$690,000.00
    - iii. possible estimated cost of modification
      - (1) materials @\$3000.00/unit is \$138,000.00
      - (2) time @4/day (field work) is 11.5 man/ days
      - (3) labor cost @ \$480.00/ day is \$5,520.00
  - e. new test equipment
    - i. higher stability oscillator
    - ii. spectrum analysis
    - iii. possible estimated cost
      - (1) 6 monitors @\$45,000.00 is \$270,000.00

**15. The best case cost estimates for the first step bandwidth reductions (projected 1/1/1996)**

- a. total cost is \$5,665,560.00
- b. total time is 2,001.65 man/ days

The worst case cost estimates for first step bandwidth reductions will exceed \$11,986,600.00 requiring the replacement of all transmitting and receiving equipment with compliant models. This projection does not consider additional infrastructure costs (\$10,000,000.00) due to emission power reduction of fixed station transmitters.

**16. It appears likely that the second step ( 1/1/2004) bandwidth reduction specified in §88.433 Spectrum efficiency standards, will result in similar costs to the city for equipment replacement. Time frames are unrealistic and do not allow for an orderly migration to new technology. The use of a multiple step transition for bandwidth reduction forces excessive short cycle replacement or modification of all transmitting and receiving equipment. One single bandwidth reduction**



step would be the most cost efficient method. Compliant product availability should be utilized in projecting realistic time frames and bandwidth reduction levels. Existing equipment and system investment must be protected in all phases of operation (reliability factors and operating range) throughout a normal attrition / replacement cycle.

17. §88.219 Trunked and loaded conventional systems on non-SMR frequencies provides for the elimination of adjacent channel mileage separation requirements . Such action will produce harmful interference and provide a noticeable reduction in radio system reliability. A minimum adjacent channel signal margin of 15 dBu (or more) should be adopted for this geographic region. Any INCREASE in interference can not be tolerated.
18. §88.219 Trunked and loaded conventional systems on non-SMR frequencies provides for the co-channel protection of services on the basis of prediction curves. Measured field intensities of interfering co-channel stations should be utilized in the protection of existing public safety stations. A minimum co-channel signal margin of 35 dBu (or more) should be adopted for this geographic region. 30 dBu interference levels over an applicants requested service area can not be tolerated.
19. Third party communication service providers would not be reliable in all situations for public safety operations and should not be licensed. Only government entities should be eligible for public safety blocks.
  - a. Labor disputes involving employee strikes can impact third party service providers causing a loss of communication services.
  - b. Contract disputes that are common in the market place could produce a forced turn off of communication services.
  - c. Profit centered service providers may not maintain necessary levels of redundancy for emergency system support. Reallocation of spare (backup) equipment is commonplace in this market area.

- d. Timely maintenance may not be provided in all cases or emergencies. Public safety licensees have had contracts with a third party providing communications. Public safety entities retain control of the license ensuring frequency availability.
20. §88.13 Public Safety Radio Service, (a) Eligibility .."Applications from persons or organizations other than governmental entities.." will allow the loss of public safety spectrum to other organizations. Control of public safety spectrum should remain with governmental entities. Legal jurisdictions overlap geographically resulting in numerous opinions concerning spectrum utilization within that geographic area. Only government entities should be eligible for public safety allocations.
21. (III) Discussion, D. Technical and Operational Rule Changes. Paragraph 20 of the Notice Of Proposed Rule Making states "Users in these services have all found 75 watts to be an acceptable power limit." The 2 largest land transportation companies in Houston do not share this opinion. Their normal service area is greater than 35 miles from downtown Houston. The proposed power levels of Table C3 would inhibit the normal functioning of the daily business operations and impact driver safety.
22. "REFARMING" must provide the quality and reliability of communications necessary for public safety radio operations. Reduced transmitter output and modulation limits will prevent many existing communication systems from operating throughout their geopolitical jurisdictions. Houston Police Department measured existing field intensities for each major site providing actual signal attenuation profiles found in jurisdiction service areas. Table C3's VHF and UHF power levels will result in unacceptable loss of system coverage. Power levels should be based on field strength and service areas, not ERP/HAAT as proposed. The use of coverage prediction data (OKUMURA URBAN) is recommended.

23. The City of Houston has collected, through direct measurement, field strength measurements for all of our major transmitting sites. These measurements were made by collecting at least 500 wavelengths of data at each specific sample point. Each sample point was identified through the use of a GPS receiver. Over 1800 data points were characterized throughout the City of Houston. This data set provides the basis for specific comments contained herein relating to signal propagation characteristics.
24. Signal attenuation profiles for major Houston Police Department sites provided good correlation with the OKUMURA URBAN propagation data. Handheld operation is required for each police system. A 40 dBu average signal level is desired for reliable operation. Computerized data provided plots (Appendix) of the sites tested.
25. Using the measured path losses for major HPD sites will allow an examination of the predicted coverage change resulting from Table C3.
- a. TCB FIELD PLOT (Appendix) shows 374 measurement points with field intensities greater than 40 dBu and 26 measurement points with field intensities less than 40 dBu for a power level of 553 watts ERP. This site is 999 feet in height and provides 25 mile coverage for handhelds @40 dBu. Okumura Urban is plotted and shows good correlation.
  - b. TCB C3 FIELD PLOT (Appendix) shows a reduction in power to 5 watts ERP resulting in projected field intensities having 61 measurement points greater than 40 dBu and 339 measurement points less than 40 dBu. Handheld coverage @40 dBu will be reduced to 6 miles.
  - c. TEAGUE FIELD PLOT (Appendix) shows 383 measurement points with field intensities greater than 40 dBu and 8 measurement points with field intensities less than 40 dBu for a power level of 300 watts ERP. This site is 516 feet in height and provides 15 mile coverage for handhelds @40 dBu. Okumura Urban is plotted and shows good correlation.

- d. **TEAGUE C3 FIELD PLOT (Appendix) shows a reduction in power to 30 watts ERP resulting in projected field intensities having 240 measurement points greater than 40 dBu and 151 measurement points less than 40 dBu. Handheld coverage @40 dBu will be reduced to 8 miles.**
- e. **BEECHNUT FIELD PLOT (Appendix) shows 272 measurement points with field intensities greater than 40 dBu and 31 measurement points with field intensities less than 40 dBu for a power level of 600 watts ERP. This site is 320 feet in height and provides 14 mile coverage for handhelds @40 dBu. Okumura Urban is plotted and shows good correlation.**
- f. **BEECHNUT C3 FIELD PLOT (Appendix) shows a reduction in power to 75 watts ERP resulting in projected field intensities having 184 measurement points greater than 40 dBu and 119 measurement points less than 40 dBu. Handheld coverage @40 dBu will be reduced to 7 miles.**
- g. **SHELL FIELD PLOT (Appendix) shows 388 measurement points with field intensities greater than 40 dBu and 35 measurement points with field intensities less than 40 dBu for a power level of 600 watts ERP. This site is 740 feet in height and provides 19 mile coverage for handhelds @40 dBu. Okumura Urban is plotted and shows good correlation.**
- h. **SHELL C3 FIELD PLOT (Appendix) shows a reduction in power to 5 watts ERP resulting in projected field intensities having 59 measurement points greater than 40 dBu and 364 measurement points less than 40 dBu. Handheld coverage @40 dBu will be reduced to 5 miles.**
- i. **PCC FIELD PLOT (Appendix) shows 280 measurement points with field intensities greater than 40 dBu and 78 measurement points with field intensities less than 40 dBu for a power level of 600 watts ERP. This site is 450 feet in height and provides 15 mile coverage for handhelds**

@40 dBu. Okumura Urban is plotted and shows good correlation. This site is shadowed from downtown Houston.

- j. PCC C3 FIELD PLOT (Appendix) shows a reduction in power to 30 watts ERP resulting in projected field intensities having 59 measurement points greater than 40 dBu and 364 measurement points less than 40 dBu. Handheld coverage @40 dBu will be reduced to 8 miles.
- k. Summary of percentage of measurements greater than 40 dBu for each site. Coverage from these sites will not be acceptable using power levels indicated in table C3.

dBu	PCC	TCB	Teague	Beechnut	Shell
>40 Std	78.21%	93.5%	97.95%	89.77%	91.73%
>40 C3	25.70%	15.25%	61.38%	60.73%	13.95%

Overall measurement points greater than 40 dBu with standard power levels average 90.2% of total. Overall measurement points greater than 40 dBu with power levels derived from Table C3 average 35.4% of total. The average 40 dBu handheld coverage area with standard power levels is 17.6 miles in radius. With power levels derived from Table C3 the average coverage area is reduced to 6.8 miles in radius, a 61.3% average loss in coverage area.

26. Okumura Urban provides a good estimate of signal propagation in the Houston area. TABLE C3 OKUMURA PLOT (Appendix) represents maximum height for a given ERP. 40 dBu handheld coverage using power limits from Table C3 are less than 10 miles. The resulting system configuration for providing good handheld coverage in the Houston area will be very costly and complex in structure. Any loss of coverage can not be tolerated.

27. The current ERP/HAAT proposal will limit the existing public safety systems of large metropolitan users possibly to the extent of endangering public safety personal. The reduction in coverage is clearly shown using actual data collected from area sites. Coordination and licensing must be based on service area and field strength contours. The contours can be a combination of predicted combined with field measured profiles for each site. Service area is required and spectrum will be used whether from 1 or 20 transmitters. There is less chance for interference (intermod, harmonics, spurs, etc.) and noise resulting from 1 transmitter. This proposal would actually require more spectrum and produce more interference to provide the required coverage for public safety. Firm ERP rules can apply but requirements will vary dramatically between entities especially when topography is a factor.
28. Spectrum efficiency -  $\eta_T$  in mobile radio communications can be defined as the product of the individual efficiencies in the domains of:
- (1) space -  $\eta_s$
  - (2) frequency -  $\eta_f$
  - (3) time -  $\eta_t$
- $$\eta_T = \eta_s * \eta_f * \eta_t$$
- a. The space factor-  $\eta_s$  is determined by the frequency of co-channel reuse within a geographic service area. Under a uniform traffic distribution condition (assumed), traffic volume is proportional to a geographic area. Carrier interference ratio- $\Lambda$  represents the required transmission quality necessary under Rayleigh fading conditions. The following equation shows the relationship between the carrier interference ratio- $\Lambda$  and the baseband signal interference ratio- SIR of a FM system under Rayleigh fading conditions. Doppler frequency-  $f_D$  and path bandwidth -  $B_o$  are included in the computation. Factors  $\theta_s$  and  $\theta_i$  are the desired and undesired signal modulation levels in radians.

$$SIR = \frac{\left(\frac{\Lambda}{\Lambda+1}\right)^2 \frac{\theta_s^2}{2}}{\frac{\Lambda}{(\Lambda+1)^3} \frac{\theta_s^2}{2} + \frac{1}{1+\Lambda} \frac{\theta_i^2}{2} + \frac{1}{2} \left[ \ln \frac{(1+\Lambda)^{\frac{(1+\Lambda^2)}{\Lambda}}}{\Lambda^{\Lambda}} - 1 \right] + \frac{99}{4} \left( \frac{f_D}{B_o} \right)^2}$$

The carrier interference ratio margin is necessary for shadow fading conditions common in metropolitan areas. The carrier interference ratio necessary to achieve a required signal to interference ratio - SIR is a function of the peak deviation of the transmitter (Appendix).

- b. The frequency factor-  $\eta_f$  is determined by the number of available channels in a given bandwidth. Carsons Rule for occupied bandwidth of a FM signal accounts for the interaction between maximum frequency deviation and maximum baseband signal frequency.

$$B = 2 (f_d + f_s) \text{ Hz}$$

Carrier drift -  $\delta f_c$  is summed with the maximum frequency deviation and maximum baseband signal frequency thus modifying the occupied bandwidth when determining the frequency factor.

$$\eta_f = \frac{1}{[2(f_d + f_s) + 2\delta f_c]}$$

- c. The time factor-  $\eta_t$  is determined by how much traffic can be sent through a radio communications channel per unit time. This factor has no relationship to modulation index. In most cases a unity time factor is assumed.

- d. Therefore, relationships between modulation index and spectrum efficiency can be made using the factors of frequency and space. Spectrum utilization is expressed as:



kHz, is better than the conventional 25 kHz, and the modulation index is optimized (large). Many public safety systems should meet this configuration, but some can not due to topology and financial constraints. One set of rules applied to all services is not in the public interest locally. A large metropolitan area can demonstrate efficiency with factors other than spectrum utilization profiles. The actual propagation characteristics (Appendix) of an urban system show that signal margins vary in excess of 25 dB for a fixed radius. Therefore, the results of predictions can have unknown variances in all areas.

30. Co-channel interference must be minimized for public safety operations. Conservative co-channel and adjacent channel distance between station parameters should be adopted for public safety. It is common practice to design for a carrier to co-channel interference ratio of greater than 17 dB at the 90th percentile. This value is not sufficient for public safety systems in the urban environment having large signal margin variances. Subjective testing will be necessary to modify the value for the environment. The control of interference within a coverage area should be the primary focus of public safety systems when considering spectrum efficiency factors and methods.
31. The requirement to cover large geopolitical areas in public safety communications is a unique set of problems. Small zone concepts applied to this area will result in additional interference producing sites thus reducing the overall efficiency factors. A single large area site, if properly loaded, may represent fewer overall variables thus providing good efficiency both spectrally and financially.
32. The following is a summary of concerns and recommendations:
  - a. Develop a separate section of the rules to apply to Public Safety only.
  - b. Change proposed channel assignments :
    - i. Eliminate interleaving
    - ii. Restore presently allocated spectrum structure.

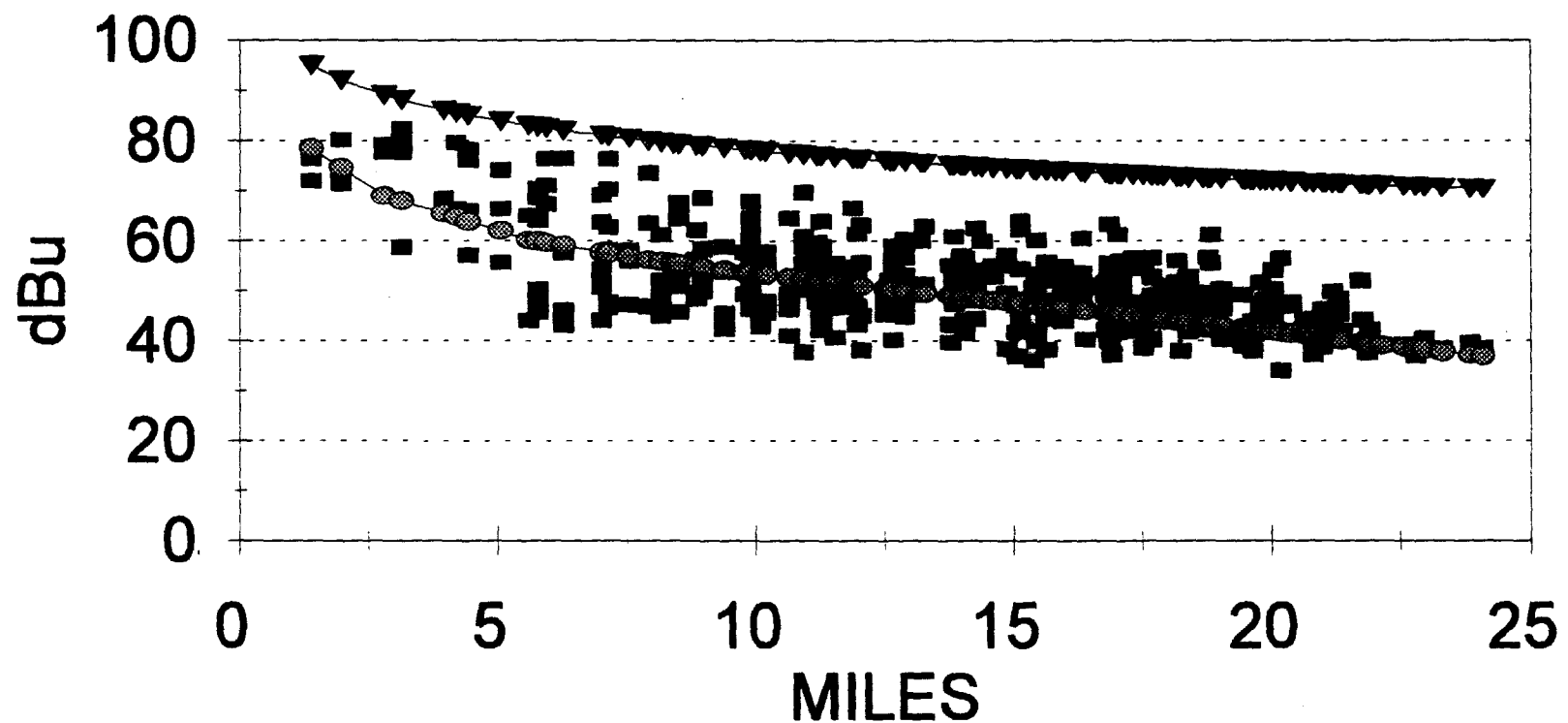
- iii. **Adopt different channel spacing methodology- ie NPSPAC**
  - iv. **Employ the existing Regional Committees to oversee the newly created Public Safety spectrum.**
  - v. **Reserve channels for mutual aid use**
  - vi. **Reserve channels for specific services within Public Safety**
    - (1) **Police**
    - (2) **Fire**
    - (3) **Medical**
  - c. **Adopt 4 kHz as the maximum modulation deviation for FM.**
  - d. **Adopt a 1 phase implementation plan to minimize cost with realistic timetable allowing timely integration of compatible equipment in existing systems.**
  - e. **Improve frequency coordination process and accuracy. Identify a single coordination entity for all Public Safety activities, while maintaining local (State) representation for coordination.**
  - f. **Adopt rules for public safety limiting radiated pattern to 40 dBu at the extreme edges of jurisdiction geographic area. Field strength plots (measured/simulated) may be necessary to ensure appropriate coverage.**
  - g. **Emission mask should be simplified to resemble a box having maximum values about a center point.**
  - h. **Adopt standards for co-channel and adjacent channel interference levels that provide a high degree of protection for Public Safety operations.**
33. **The comments offered in this document represent a concern for the utilization of spectrum efficient technology at a cost that is manageable within the constraints of good economic policy. Public safety has enjoyed a very high level of quality in its ability to communicate by radio. The continued support of the Federal Communications Commission is greatly appreciated.**

# **APPENDIX**

Site #	Site Name	Site Address	Latitude	Longitude	Ant. Hgt.
1	PCC	61 Rlesner St	29-45-55 N	95-22-12 W	470'
2	Shell	914 Louisiana St	29-45-32 N	95-22-03 W	710'
3	Water Maint.	2700 Dalton St	29-42-07 N	95-16-25 W	320'
4	SS#4	4503 Beechnut St	29-41-15 N	95-27-05 W	320'
5	Teague	5850 Teague St	29-51-19 N	95-32-21 W	516'
6	Academy	17000 Aldine Westfield	29-57-57 N	95-21-47 W	162'
7	Lake Houston	13505 Aqueduct Rd	29-54-47 N	95-08-47 W	516'
8	FS71	15200 Space Center Blvd	29-34-55 N	95-07-39 W	166'
9	Clodine	21002 FM 1093	29-42-17 N	95-44-54 W	400'

# TCB FIELD PLOT

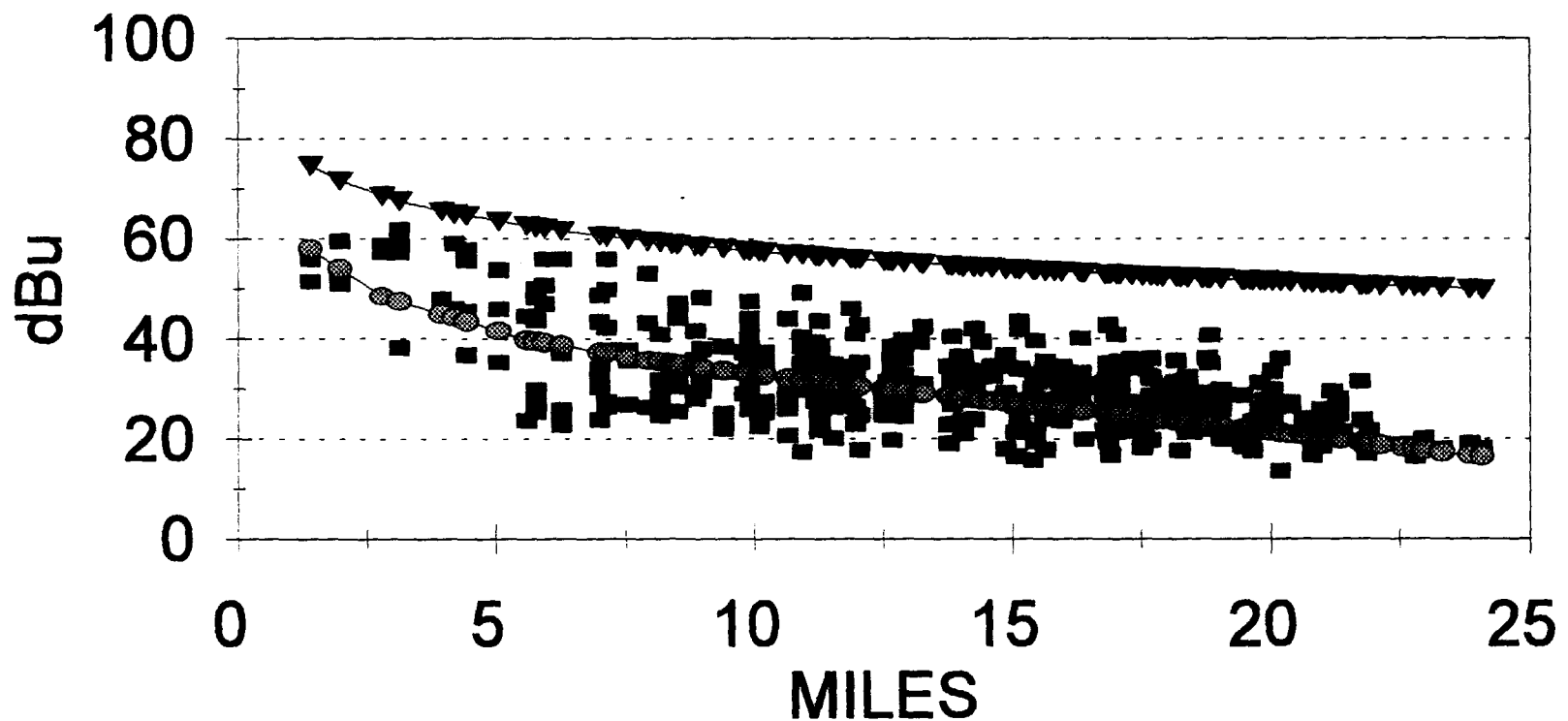
460.450 MHz 999'



■ 553 W      ● OKUMURA      ▼ FREESPACE

# TCB C3 FIELD PLOT

460.450 MHz 999'



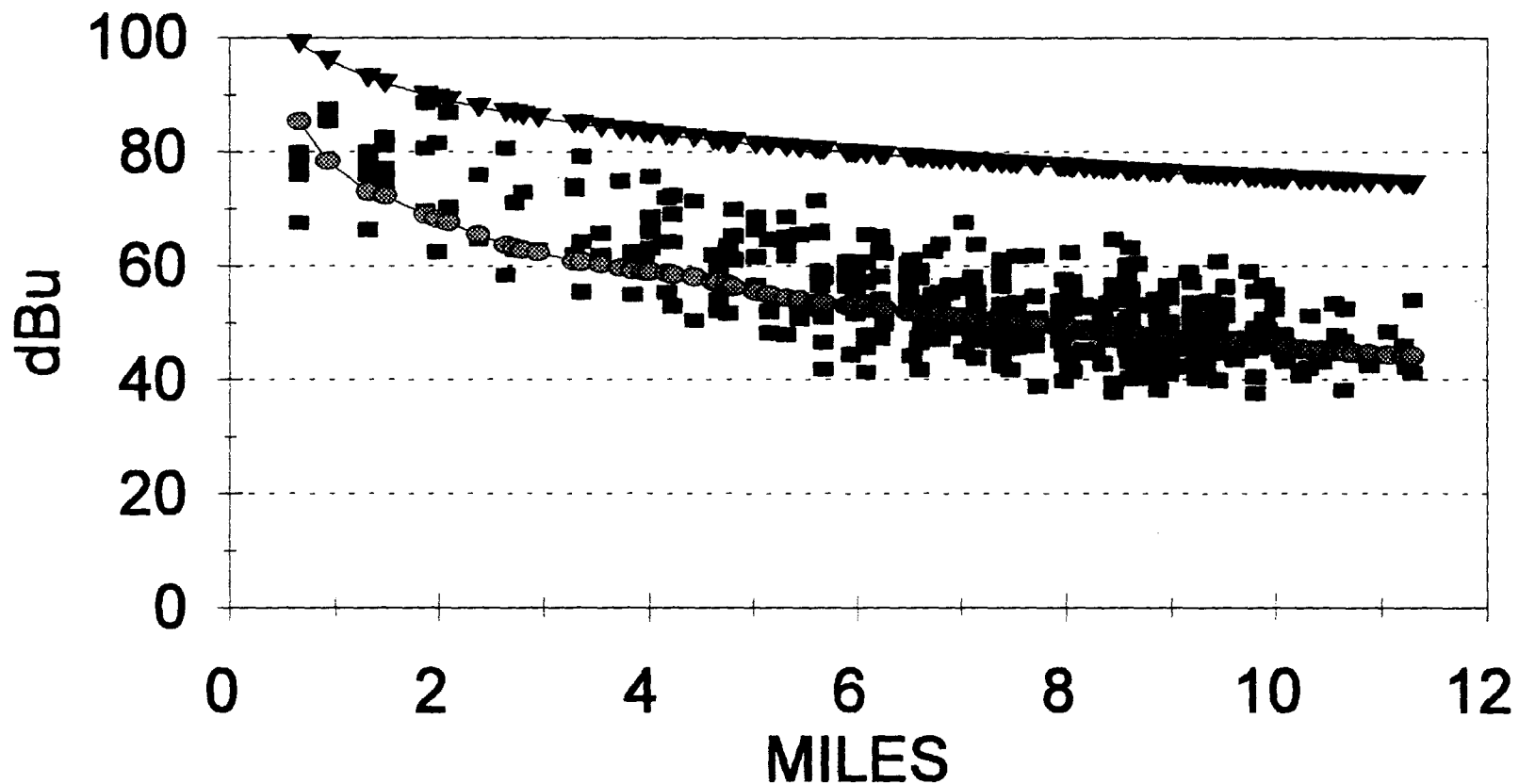
■ 5 W

● OKUMURA

▼ FREESPACE

# TEAGUE FIELD PLOT

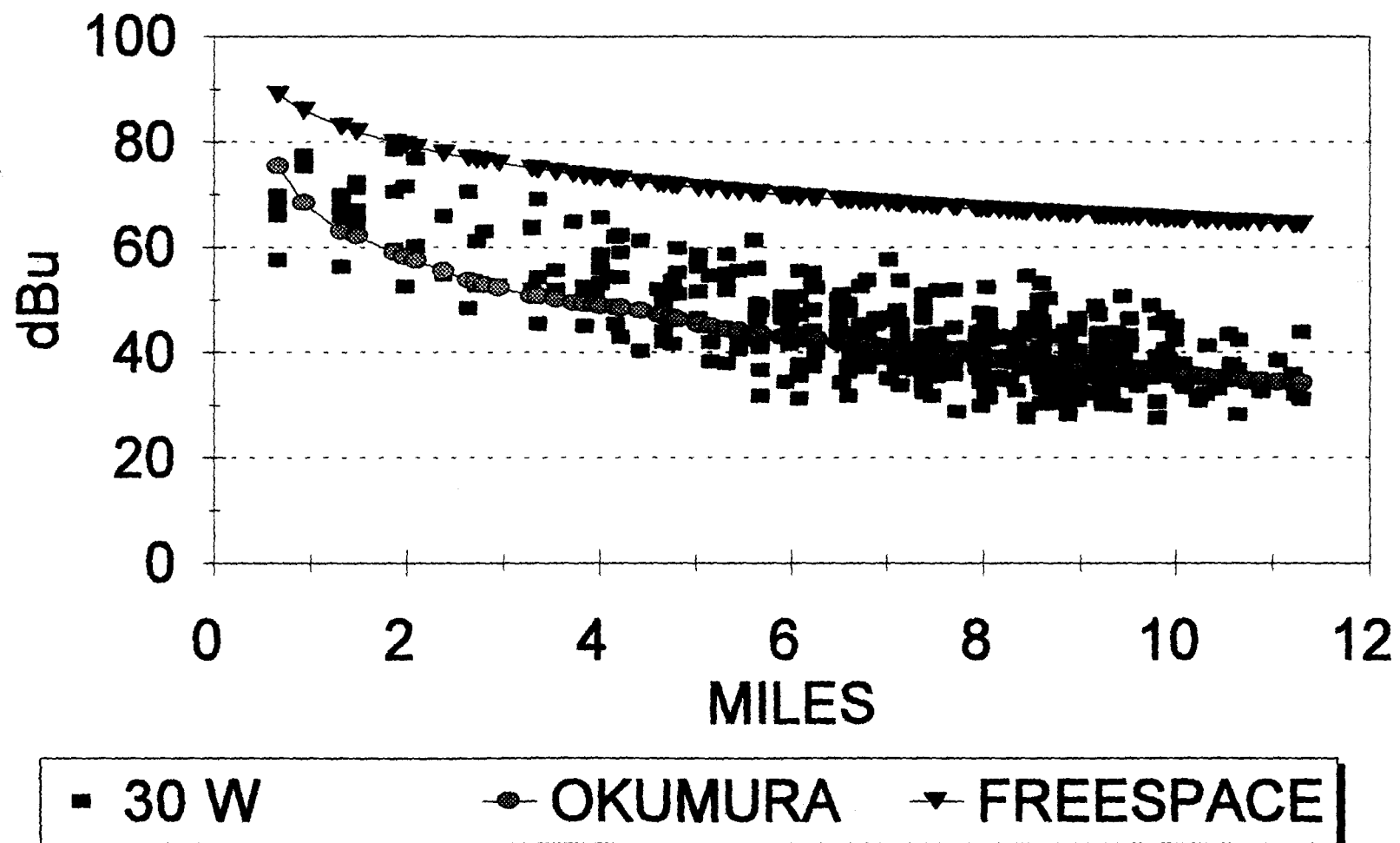
460.325 MHz 516'



■ 300 W      ● OKUMURA      ▼ FREESPACE

# TEAGUE C3 FIELD PLOT

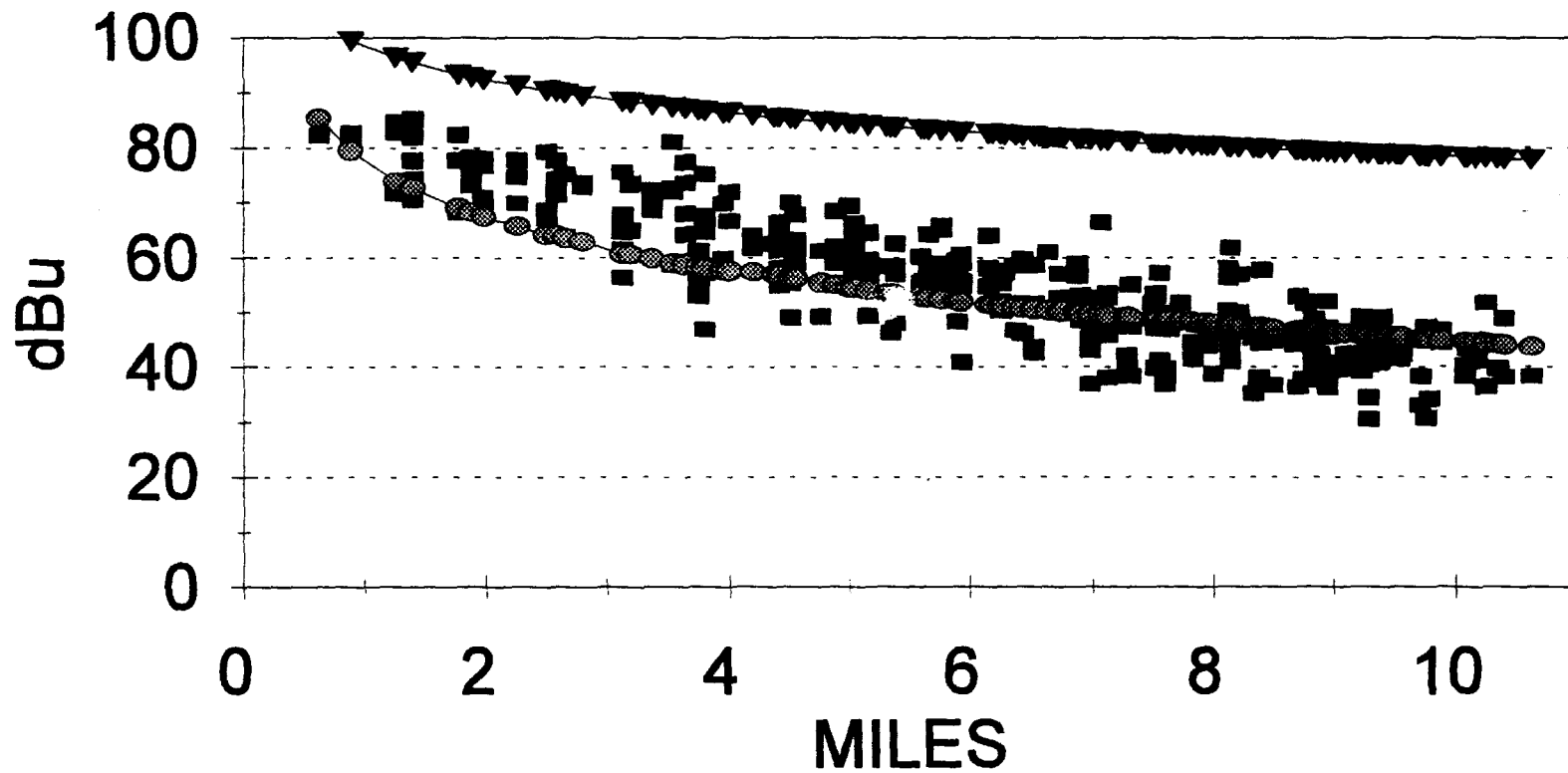
460.325 MHz 516'





# BEECHNUT FIELD PLOT

460.550 MHz 320'



■ 600 W

● OKUMURA

▼ FREESPACE